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Volcanic Gas Emissions Mapping Using a Mass Spectrometer System

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Introduction

The visualization of hazardous gaseous emissions at volcanoes using *in-situ* mass spectrometry (MS) is a key step towards a better comprehension of the geophysical phenomena surrounding eruptive activity. *In-situ* gas data consisting of helium, carbon dioxide, sulfur dioxide, and other gas species, were acquired with an MS system. MS and global position system (GPS) data were plotted on ground imagery, topography, and remote sensing data collected by a host of instruments during the second Costa Rica Airborne Research and Technology Applications (CARTA) mission. This combination of gas and imaging data allowed 3-dimensional (3-D) visualization of the volcanic plume and the mapping of gas concentration at several volcanic structures and urban areas. This combined set of data has demonstrated a better tool to assess hazardous conditions by visualizing and modeling of possible scenarios of volcanic activity. The MS system is used for *in-situ* measurement of three-dimensional gas concentrations at different volcanic locations with three different transportation platforms: aircraft, auto, and hand carried. The demonstration for urban contamination mapping is also presented as another possible use for the MS system.

Map of Costa Rica's major Volcanoes. Notice the close proximity of Turrialba and Irazu to San Jose, the major population center of Costa Rica.



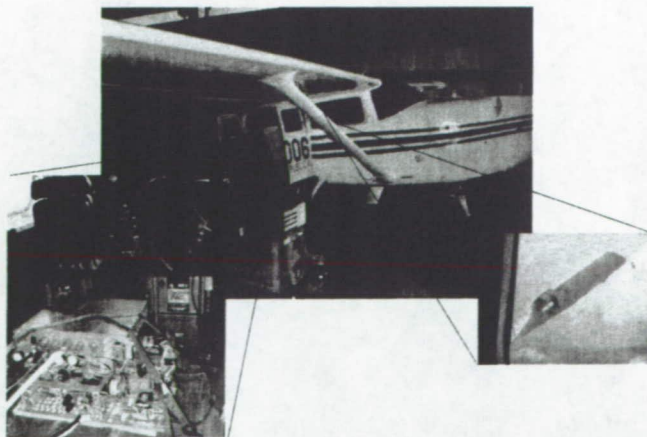
Instrumentation

Airborne Volcanic Emission Mass Spectrometer (AVEMS)

- Multiple Deployment Methods
 - Aircraft
 - Automobile
 - Hand-Carried
- 38.5 Kilograms
- 200 Dalton Scan Range
- 92,000 cm³
- 350 Watts
- 12.49 Kilometers (41,000 Feet) Above Sea Level, Maximum Altitude
 - -65 °C
 - 50 torr
- Monitor 16 Gases

This study:

- Monitored Four Gases
 - Helium, Carbon Dioxide, Sulfur Dioxide, and Acetone
- Acquired GPS dTda
- Ground Imagery, Topography, and Remote Sensing Data
 - Other Instruments
- Aircraft and Hand Carried
 - Two CESSNA Aircraft
- Flights Duration: 30 min to 2 hour
- Altitude: Up To 4.57 kilometers (15 000 feet)
- Power: Two 24 V Batteries and Inverter



Pictures showing the AVEMS, GPS, sample line, and aircraft used for parts of this study. The AVEMS was secured in the aft door of the aircraft and the GPS along with the sample line were located on the starboard wind strut. This location was selected to help lower the amount of exhaust monitored.

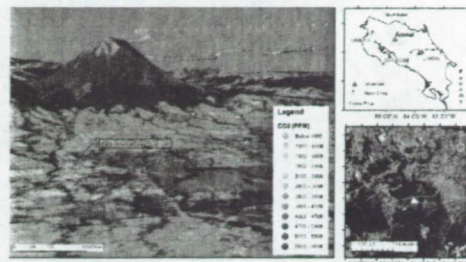
Results and Discussion

Data Collected

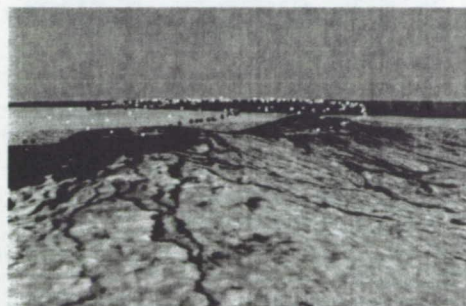
- Concentration
- GPS

DATA Plotted

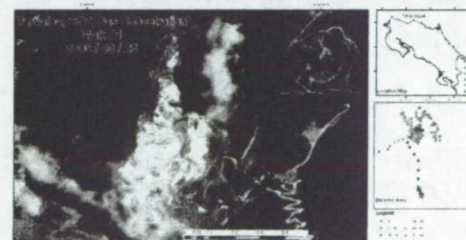
- On 3-D Image of Area
- Position of Plume are Visible in 3-D Model



CO₂ data plotted for the Arenal Volcano. The Data were acquired by aircraft-based instrument.



CO₂ data plotted for Turrialba and Irazu Volcanoes. The Data were acquired by aircraft-based instrument.



CO₂ data plotted for Turrialba and Irazu Volcanoes. The Data were acquired by hand-carried instrument.

Conclusions

A Versatile Instrument Was Developed and Deployed

- Acquired Gas Concentrations
 - Aircraft
 - Automobile
 - Hand-Carried
 - Parts-per-Million (ppm) Detection Limits
- Mapped Volcanic Plumes

A Useful Tool

- Further Understand Challenges to Deploy Instruments
- Understand Plume Behavior

Future Work

- Ground Reference for Space-Based Monitoring
- Time Changes of Plume
- Improved Instrument/Integrate Different Technologies

Acknowledgments

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